Light and Lighting

Official Journal of the Illuminating Engineering Society.

Incorporating "The Illuminating Engineer."

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Don't Miss A Chance!

WE all know the rather irritating enthusiast who, after outlining a well-nigh impossible programme, and without any pause for the consideration of ways and means, adds impressively: "I want to be sure that we shall not miss *any* chances."

In actual life we all miss chances, as well as taking them—and the more active the field in which we operate the greater the number of chances that we shall certainly miss.

Perhaps it would be difficult to find a field offering more chances, of every possible description, than illuminating engineering. The chances come first through the inherent value of the commodity we offer — not always properly understood and appreciated by the community even to-day. And secondly from the fact that illuminating engineering is itself such a live subject, in a state of continual ferment, offering new lighting equipment and new ideas for using it.

At the present moment we seem to be on the threshold of our post-war developments —of all the fine things we plan to do in the future. The chances about to be offered to us may be greater and more numerous than ever before.

Let us at least grab all we can.

I.E.S. Programme for 1944-45

The present month is always a somewhat awkward one, during which preparations for the autumn should be undertaken, though holidays and absences—added to war-time distractions — tend to delay decisions. All those concerned, either as authors or initiators of papers, are asked to round off their jobs so far as possible. The programme for the next I.E.S. session is well in hand and promises to be an interesting one. In one respect it will certainly be quite as remarkable as last session. The total number of meetings, which last session actually exceeded the number for 1938-39, should attain a new record, and this without the special sectional meetings which contributed so largely to the pre-war totals. Secretaries of Centres and Groups should keep each other informed of developments so that specially desirable items may be repeated in different localities. The entire provisional programme should be available before the beginning of October. The position this year is, however, complicated by the hope that in the course of the session a return, at least in part, to peace conditions may become possible. This would at once open up new possibilities and might lead to the modification and augmenting of existing programmes, and the incorporation of new features whilst the session is in progress.

"Plant Housekeeping"

Under this intriguing title the I.E.S. Lighting Review recently reviewed the subject of "Three dimensional painting" as now being practiced in up-to-date American factories. Some reference to this topic, which has been the subject of much discussion recently, is made elsewhere in this issue (pp. 128-130). Practice goes far beyond the mere use of light colours to reflect light. In the Lafayette plant of the Avondale Cotton Mills, for instance, there is a definite pictorial colour scheme, not only more agreeable psychologically, but aiding safety very materially by accentuating certain objects. In a chart, reproduced in our contemporary, the use of white for the ceiling, sea green for the upper walls, and light grey for stationary individual objects in the upper part of the room is indicated. Below the colours for machinery are mainly jade green, red, and brown. High visibility yellow is recommended for moving equipment, electric trucks, boxes, etc., and either this colour or bright red for controls and starting handles. Bright red is also advised for accident hazards, as a supplement to mechanical safeguards. Evidently such colour scheming and the lighting design should go hand in hand.

Post-War Street Lighting

From a recent contribution by Mr. H. E. Mahan to *Illuminating Engineering* (June, 1944, p. 346) it would appear that American lighting engineers, like their British colleagues, have made up their mind that no sensational new developments in the technique of street lighting are to be expected in the near future—at least during the immediate post-war years. Quite apart from such visionary schemes as lighting from the kerb or from captive balloons, it would seem that no very radical changes in fittings design are anticipated and, as already reported,* an inquiry has led to the impression that there is not much opening for fluorescent lighting in connection with the great bulk of road lighting. In America the chief development will be the extension of existing methods. The public has to catch up with established standards of street lighting rather than to acquiesce in the setting up of new standards requiring new designs. In the main this conception also applies to this country, though there are several special factors at work here. The British public has already endured five years of almost complete darkness in its streets. Will its post-war reaction be an exhuberant demand for more light irrespective of quality; or will its experience render it less tolerant of brightness accompanied by some degree of glare? We have been speaking above of technical problems of street lighting. The need for reform on the administrative side is much more evident. It seems highly probable that war-time experiences will hasten the introduction of some form of central supervision of public lighting so far as important national thoroughfares are concerned.

* *Light and Lighting*, July, 1944, p. 114.

American I.E.S. New Secretary

It is something of a coincidence that, whilst the Illuminating Engineering Society in this country is inviting applications for the post of secretary, the American I.E.S. is losing the services of Mr. F. G. Horton, who has served as executive secretary for 20 years. Mr. Horton, it is stated, has accepted the position of managing secretary of the Engineering Society of Detroit. An appreciative reference is made to his services, and a tribute is paid to the smoothness with which the administration of the Society's affairs has gone forward for the past two decades is made in *Illuminating Engineering* (June, 1944).

Illuminants for Colorimetry

A lecture on "Illuminants for colorimetry and the colours of total radiators" is to be given by Mr. H. G. W. Harding to the Colour Group of the Physical Society on September 20. The meeting will be held at the E.L.M.A. Lighting Service Bureau (2, Savoy-hill, London, W.C.2) at 3.30 p.m. The lecture will deal with the recommendations of the Commission Internationale de l'Eclairage in 1931 and with other proposals, and the way in which coloured filters are used at the National Physical Laboratory to establish the colour temperature scale above 2,400° K will be described.

Lighting Education

The education of the lighting engineer is rightly considered a very pressing matter to-day, and is being keenly discussed both here and in America. A frank and entertaining analysis of "Lighting Education," by Mr. C. A. Atherton (*Illuminating Engineering*, June, 1944), is therefore timely.

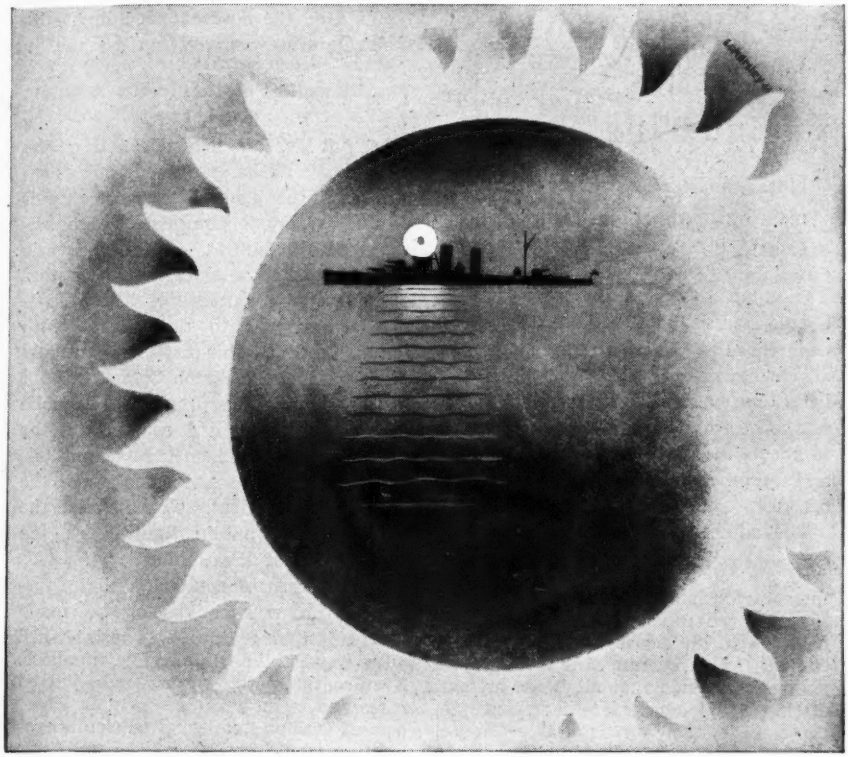
The author's own entry into this field was made in 1920, when the industry was just realising the value of demonstration methods in approaching the public. The users of these devices all thoroughly believed in the value to the consumer of more light, and it quickly became usual to by-pass elaborate and fundamental methods (such as the old "point-to-point" basis of calculation) and get straight to fundamentals.

The education to specify lighting on 1920 lines was not very arduous—the salesman could learn the essentials in a few days at some lighting centre and could then calculate as well as the professor—but it was at least more practical and better than the methods it displaced. The drawback was that it ignored fundamentals so completely and was not, measured by to-day's needs, an educational programme at all.

At that time European engineers were mostly of the "slide-rule" type. They knew how to calculate with precision and had a better knowledge of fundamentals than American engineers—but they could not see or make others see the significance of the values they calculated. There were heated discussions over education. "The Europeans accused us of education for the sole purpose of selling light. . . . Our reply was that pure knowledge got us nowhere . . . no one did anything with beautiful figures and calculations."

Eventually the American method won out—in fact, some countries went further than America had done. Mr. Atherton describes conditions in 1939 in Germany, where there were over 200 lighting demonstration centres and innumerable lectures and talks to selected groups. The demonstration centres were beautiful, spectacular, and impressive. "Literally hundreds of tricks which impressed and over-impressed you with the need for more light . . . automatic shutters, self-operating attention getters . . . the grave, perspiring audiences, the pompous, ingratiating professors, the incontrovertible proof of the indubitable profit in buying light."

It is curious, therefore, that there is now in America a swing-back to the fundamentals. The present method is better than the 1920 "more-and-better-light" methods, certainly better than the old-fashioned "cosine-chasing" methods which preceded them. But attempts are now being made to analyse the problem more profoundly. Lighting education is a two-pronged affair—one prong with which we in the lighting industry prod ourselves, and the other with which we should be prodding the users of lighting. The inner prong involves a more serious approach to I.E.S. affairs and to our own education. The emphasis on fundamentals, however, is shifting slightly. In years gone by it was placed first on candle-power and then on foot-candles. Now *brightness* is becoming the criterion, though surely one day even brightness will only be a factor. We are entering a new but not the final era. One advantage of brightness over foot-candle engineering is that the concept is much easier to visualise—a fact that should be helpful in interesting architects, doctors, and other allied experts in illuminating engineering.



Stars that twinkle in the sun . . Three miles out to sea a small electric lamp twinkles out its message and competes with the glare of an Italian sun. How is it done? The light is concentrated by an intricate combination of highly-polished lenses and prisms which are calculated to throw an intense beam of light. In fact, it is a concentrated "lighthouse".

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Special Problems in Illuminating Engineering

Notes on subjects discussed at a meeting of the I.E.S. Birmingham Centre on February 25th, 1944.

Some of the most interesting meetings arranged by I.E.S. Centres have been those at which a variety of topics are briefly discussed. Although some little time has elapsed since the holding of the meeting at Birmingham referred to above, the material is still of interest and the procedure worth noting by other centres.

The success of such gatherings depends greatly on the selection of subjects and on the number and nature of the contributions. It is a mistake to try to cover too much ground. Probably five (as in this case) or six items is enough for an evening. It is also good policy to arrange that all items are not of the same character—for example, some may touch on debatable general topics, whilst others deal with specific technical problems.

On this occasion two of the contributions, by Mr. T. H. Varcoe and Mr. R. Mackenzie, were in the first category; two, by Mr. F. Bate and Mr. J. H. Forth, were in the second class; whilst the other item, presented by Mr. V. A. Heydon, might be regarded as intermediate.

The Necessity for Adequate Industrial Lighting

Mr. Varcoe's talk on this subject was well illustrated by "before and after" pictures of installations recently brought up to standard, and he pointed out in general terms the advantages of good industrial lighting. In particular, he was at pains to demonstrate that if one took into account all the relevant factors—reduction in spoilage, diminution in accidents, and in losses of man-hours, etc., the cost of providing adequate lighting was well worth while.

The Difficulties of the Public Lighting Engineer

We put Mr. R. Mackenzie's talk on the problems of the public lighting engineer in the general class because it related largely to administrative handicaps and difficulties. Mr. Mackenzie pointed out as a chief weakness that very few local authorities had a separate department to deal solely with public lighting. This matter was usually dealt with by the Watch Committee, but in other cases the provision of public lighting was regarded as one of the duties of the Cleansing Committee, whilst in yet others it came under the Salvage Department. This justified the description of public lighting as the "Cinderella of the Public Services."

Mr. Mackenzie contended that satisfactory progress could not be made until a direct contact was established with a Public Lighting Committee. Even so, the matter was apt to be judged mainy in terms of cost—in many cases a most serious item—and efficient street lighting would not be general until this problem was eased by Government grants in appropriate circumstances. An adequate street lighting service should not be considered extravagant, nor should it be unduly expensive if regard was paid to the effect of accidents, the consequent loss in working hours, and the compensation to be paid. Authorities should be educated to insist on Government aid in pressing cases and the consideration of good street lighting along with schemes relating to housing, health, etc., as part of the general reconstruction programme.

Lighting Schemes and Drawings

Mr. V. A. Heydon, who discussed desirable methods to be adopted in preparing lighting schemes, dealt with what is essentially a technical problem but yet is one of considerable general interest. His chief contention was that

a better understanding is necessary in preparing such schemes for presentation, so as to be "foolproof" and to exhibit all essential requirements clearly. In particular he stressed the need for a standard method of marking lighting points and their coding on scaled plans. Standard procedure should be adopted by all firms in the lighting industry when preparing specifications. This was a point which the I.E.S. might take up with advantage.

Lighting in the Drawing Office

Mr. F. Bate described an installation recently carried out by him in a drawing office. He recommended a general illumination of 50 foot-candles on the work, but emphasised the importance of allowing sufficient upward light to prevent unduly sharp contrast between the brightness of the drawing board and the surroundings. Walls should be graduated in tint, having a light colour at ceiling level toning down to pale green near the floor. Such methods would do much to diminish the fatigue generally experienced in drawing offices where as many as 50 per cent. of workers and draughtsmen sometimes suffered from defective vision.

The Inspection of Ball Bearings

This item, dealt with by Mr. J. W. Forth, was, like the preceding one, a special technical problem. The author explained that highly polished objects such as ball bearings could not be comfortably inspected under ordinary lighting. He had found that the most satisfactory method of dealing with this problem was to construct a special cylindrical chamber, finished matt white inside, and lighted by means of a 60-watt lamp in a reflector fitted to the top. Two circular holes were made at the side of the chamber, and through which the balls could be inserted and withdrawn by the inspector. The actual inspection was made through a magnifying lens inserted in the front of the chamber, and the balls were viewed by an illumination of the order of 500 foot-candles.

Civic Meeting in Birmingham

A forthcoming event of considerable interest is the Civic Meeting, initiated by the I.E.S. Birmingham Centre, which will be held at the Council House, Birmingham, on September 29. The Lord Mayor of Birmingham will welcome those participating. Addresses will be given by Councillor L. G. Potts, Mr. J. G. Holmes, Mr. R. O. Ackerley, and Mr. H. J. Manzoni (City Engineer and Surveyor). An exceptional opportunity of discussing the part to be played by lighting in post-war reconstruction will be afforded. It is hoped that the Conference will be opened by the I.E.S. president (Dr. H. Buckley).

Developments in the Gas Industry

Owing to war conditions it was not found possible to hold the eighty-first annual general meeting of the Institution of Gas Engineers, which had been planned to take place in Edinburgh in June. The Institution has, however, published six short papers, which were to have been presented and discussed and are now issued in pamphlet form under the title "The Gas Industry: Some Factors Influencing Future Development."

These papers fall broadly into three classes, dealing respectively with the provision of staff, the organisation of research, and the design and fittings of gas appliances in post-war houses.

Like others, the gas industry is devoting much attention to the post-war training and education of the staff on which the Director of Research, Dr. J. G. King, has constructive ideas to offer.

A technical point of considerable interest is that discussed by Mr. Arthur Foreshaw, namely, the choice between aerated flames, such as the Bunsen burner, or non-aerated flames, described as "all-gas." Great future developments in water-heating are visualised. Of over 9,000,000 families with incomes below £300 a year no less than 62 per cent. have still no running hot water supply.

Overhead "Skylights" in a Foundry

It has been often urged that the best results are obtainable from fluorescent lighting when the resemblance to daylight is almost complete, but its drawbacks are avoided.

The inherent advantages of natural lighting include high intensity, colour, good diffusion and absence of glare, and—when daylight is unrestricted—very even distribution. Drawbacks arise as soon as we attempt to arrange admission of light into rooms through windows which, if on one side of the room only, may give rise to great inequalities.

In imitating daylight, therefore, we usually prefer the arrangement of artificial skylights overhead. A good example of such methods is seen in the accompanying illustration, for which we are indebted to the British Thomson Houston Company, Ltd. This picture shows the main foundry of the Wycliffe Foundry and Engineering, Ltd., and the installation consists of 16 Mazdalux roof laylights, each housing six Mazda 80 watt 5 ft. fluorescent lamps.

The average illumination is approximately 6 ft.c. The laylights are spaced 20 ft. apart laterally and 28 ft. longitudinally and, as the photograph suggests, the light is very evenly distributed.

The installation was carried out by The Electric Equipment Company, Ltd., Leicester.

A view of a foundry in which lighting is furnished by overhead laylights containing fluorescent lamps and producing an effect closely resembling that of natural daylight.

I.E.S. Transactions

No issue of the *I.E.S. Transactions* is being made during the month of August. The next copy will be circulated simultaneously with the September issue of *Light and Lighting*.

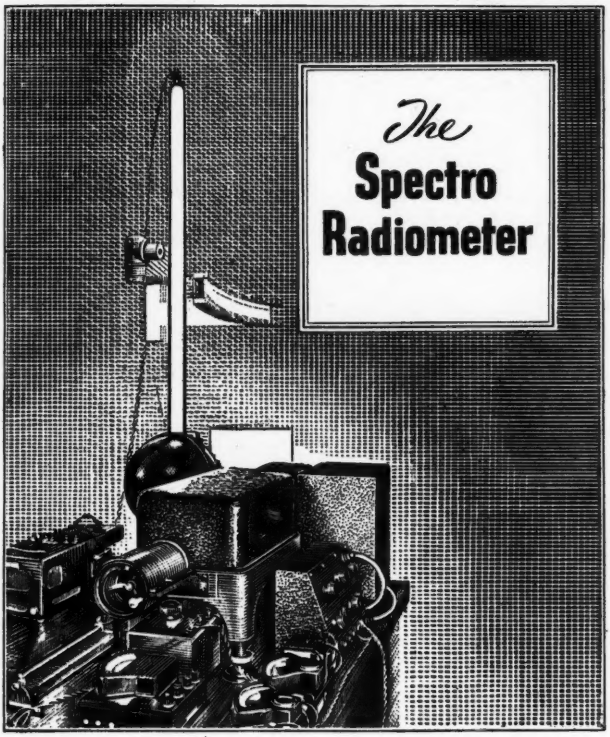
SITUATION WANTED

LUMINESCENT MATERIALS. — Research Chemist (Ph.D.) with many years' experience in development and manufacturing of luminescent materials, present task approaching completion, soon available for new position.—Write Box No. 550, "Light and Lighting," 32, Victoria-street, London, S.W.1.

SITUATION VACANT

SALES REPRESENTATIVE required for Illuminating Engineering Department of Lamp Manufacturers. Experience in planning industrial lighting essential.—Write, with details of age, experience, and salary required, to Box C.G. 9, c.o. 5, New Bridge-street, London, E.C.4.

RESEARCH BEHIND LIGHTING



THIS remarkable device splits up light into its component wavelengths and measures the amount of energy radiated at each wavelength. The use of a double monochromator and delicate galvanometers and valve amplifiers enables analyses to be made with precision.

The Spectro-radiometer is used, with many other scientific instruments, in the BTH Laboratories, in a constant endeavour to maintain and improve the quality of the famous Mazda Lamp.

BTH RESEARCH AIDS INDUSTRY

BTH Research Laboratories have made an intensive study of both the physical and psychological aspects of lighting in war-time industry, and their knowledge and experience are at the disposal of the principals of industrial undertakings through the Lighting Advisory Service.

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Literature on Lighting*

(Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

(Continued from p. 46, March, 1944)

PHOTOMETRY

18. Illumination Conversion Chart for Inclined Work Planes. K. Franck. Am. Illum. Eng. Soc. Trans., pp. 245-252, April, 1944. A monograph is given for rapid evaluation of the relation between the illumination on a horizontal plane and that on an inclined plane. Examples and the derivation of the chart are given. J. S. S.

SOURCES OF LIGHT AND LIGHTING EQUIPMENT

19. Brightness of Cylindrical Fluorescent Sources. E. A. Lindsay. Am. Illum. Eng. Soc. Trans., pp. 23-30, January, 1944. It is suggested that the brightness of a tubular fluorescent lamp (of less than 4 in. diameter) should be specified as the average brightness of a strip, the full diameter of the lamp, having a total area of 1 sq. in. Methods of measuring and calculating the brightness are discussed. J. S. S.

20. An Emergency Signalling Mirror. W. M. Potter. Am. Illum. Eng. Soc. Trans., pp. 253-258, April, 1944. A pocket-sized solar signalling mirror is described, incorporating a simple but accurate aiming device. J. S. S.

21. Design of Lighting Fittings. "Megohm." Electrical Times, Vol. 105, No. 2724, January 6, 1944. The author discusses the general trend of fittings design, particularly in relation to standardisation and mass-production. While artistic demands may limit the extent of standardisation, components such as lamp-holders and back plates can be standardised. He advocates the direct-on-ceiling fitting for small rooms and a tube lead-in for all types of fitting. W. E. H.

APPLICATIONS OF LIGHT

22. Notes on Lighting Progress. I.E.S. Committee on Progress. Am. Illum. Eng. Soc. Trans., pp. 595-616, December, 1943. A review is given of lighting developments in America during 1943. Particular reference is made to fluorescent lamps and their fittings. J. S. S.

23. Modern Lighting Practice. Anon. Am. Illum. Eng. Soc. Trans., pp. 10-12, December, 1943; January and February, 1944. Representative lighting schemes are described with photographs. J. S. S.

24. Brightness Engineering. M. Luckeish. Am. Illum. Eng. Soc. Trans., pp. 75-92, February, 1944. A summary is given of the author's numerous researches on the effect of brightness contrast and glare on the performance of the eye. J. S. S.

25. The Basis of Night Vision. G. L. Wallis. Am. Illum. Eng. Soc. Trans., pp. 93-109, February, 1944. After an account of the physiological background of night vision, the process of adaptation and the possibility of accelerating it is discussed. The author concludes with a discussion of the best colour for illumination in black-out conditions. J. S. S.

26. "White" Floors. W. G. Darley. Am. Illum. Eng. Soc. Trans., pp. 112-119, February, 1944. The use of light floors to provide illumination on the underside of work in factories is discussed. It is concluded that for detailed work reflected light is insufficient, but is useful for rough work and in reducing brightness contrasts. J. S. S.

27. On the Rate of Involuntary Blinking. M. Luckeish. Am. Illum. Eng. Soc. Trans., pp. 69-71, February, 1944 Dr. Luckeish comments on the work of Dr. Sheila MacPherson on the blink rate as a criterion of ease of seeing. His work involved the task of reading, the blink rate cannot necessarily be applied to any other visual task. J. S. S.

28. Fluorescent Sources at Work. R. D. Bradley, F. B. Lee. Am. Illum. Eng. Soc. Trans., pp. 13-21, January, 1944. The authors compare critically a large existing cold cathode high-voltage fluorescent tubing installation with a design using 230-V. 40-W. fluorescent lamps to give the same performance. J. S. S.

*We regret that we are unable to furnish copies of original articles to readers.—Ed.

29. Design and Maintenance of Fluorescent Lighting Installations. J. N. Aldington. Electrical Times, Vol. 105, No. 2730, February 17 and 24, 1944. After a brief summary of the characteristics of the 80-W. fluorescent lamp, the author deals in some detail with the design of control gear, routine maintenance, and the planning of different types of installations. He discusses installations using 5-ft. lamps for both general and local lighting, and comments on the design of suitable fittings. The advantages of fluorescent lighting are illustrated by reference to a 3-tube hospital operating theatre fitting, and to a large rolling mill, and to assembly benches. Where installations using low-mounting heights are being considered, and, in particular, the lighting of a localised area, the author suggests that iso-foot-candle diagrams should be used. For general lighting, methods using co-efficients of utilisation may be employed. The final section of the article deals with lamp performance and replacement. W. E. H.

30. Operating Characteristics of Ultra-violet Light Sources in Modern White-print Machines. F. G. Wilde. Am. Illum. Eng. Soc. Trans., pp. 31-49, January, 1944. The paper discusses the use of long (46-in.) and short (1.5-in.) high-pressure quartz jacketed mercury vapour lamps in reproducing machines, where the original and the sensitised paper are rotated on the surface of a transparent drum at the axis of which the light source is located. Mathematical analysis shows that with the long source the exposure is not dependent on the diameter of the drum if the latter does not exceed about 30 per cent. of the active length of the lamp source. It is also shown that if the drum diameter exceed six times the length of the lamp the lamp may be considered as a point source. With the short lamp, therefore, sharp micro-prints may be obtained more easily. J. S. S.

Additions to I.E.S. Membership List.

The following applicants have been duly elected by the Council to membership in the Illuminating Engineering Society, and their names have been added to the list of members:—

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Messrs. Geo. Bray and Co., Ltd. ..... *Representative*: E. Cawood
Leicester Place, Blackmans Lane, LEEDS 2.

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Freeman, E. W. .....328, Scraptoft Lane, LEICESTER.
Felton, F. D. .....Stresa, Spring Hill Lane, Penn, WOLVERHAMPTON.
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Holt, J. M. .....55, Caversham Avenue, Palmers Green, LONDON, N.13.
Kerr, E. S. .....7, Pincott Road, Bexleyheath, KENT.
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McGill, D. .....24, Lindislane Road, Shipley, YORKS.
Maude, R. .....66, Crown Street, HALIFAX.
Smith, W. A. .....47, Iona Street, EDINBURGH 6.
Walker, H. P. .....c/o Plastics Dept., Imperial Chemical Industries, Ltd., "Belmont," The Ridgeway, Mill Hill, LONDON, N.W.7.

STUDENTS:—

Bowles, P. J. .....253, Chester Road, Castle Bromwich, Near BIRMINGHAM.
Hirons, Miss P. .....28, Dalbury Road, Hall Green, BIRMINGHAM 28.
Leeming, G. .....32, St. Augustine's Terrace, Hanson Lane, HALIFAX.

TRANSFERS TO CORPORATE MEMBERS:—

Burdes, L. .....Bristol Corp. Electricity Dept., Dorset House, Clifton, BRISTOL 8.
Reed, D. J. .....Research Laboratories, The General Electric Co., Ltd., East Lane, Wembley, MIDDX.

(N.B.—This list of names will be embodied in the next list formally published in the Transactions of the Society.)

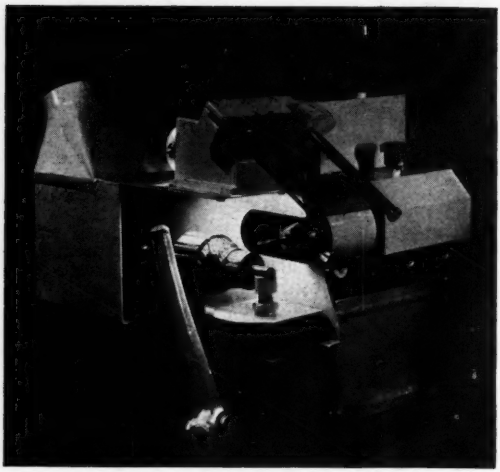

Fig. 1. A commutator under-cutting machine, showing special local lighting and background to work.

By the courtesy of *Sheet Metal Industries* we reproduce below two outstanding examples of local lighting mentioned in Dr. J. H. Nelson's article (summarised in our July issue, page 106). Fig. 1 shows the effect of special local lighting of a commutator undercutting machine. The source of light was a small opal glass panel illuminated by a 12-V, 36-W lamp, which is reflected in the commutator surface, and a cream-tinted brightly-lighted background is provided. Fig. 2 shows the advantage of using polarised light for the examination of synthetic sapphires. The jewels (themselves doubly refracting) rest on a sheet of material transmitting polarised light, and are examined through another sheet of polarising material so set that light from the first sheet is quenched; the jewels then stand out brightly against a darker background.

Two Outstanding Examples of Local Lighting

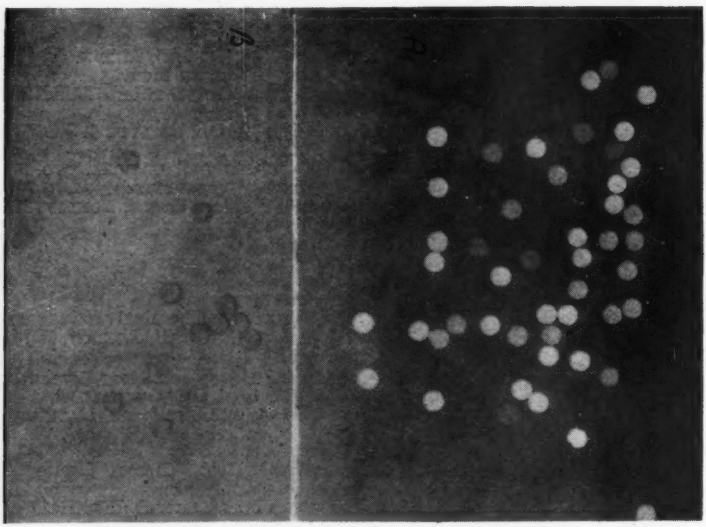

Fig. 2. Examination of synthetic sapphires. Increased visibility results from the improved contrast when polarised light is used.
(*Left*). Jewels in ordinary light. (*Right*). Jewels in polarised light.

Colour-Contrast Speeds Clothing Production

An interesting point in connection with the lighting of modern knitting machines was recently discussed in the *I.E.S. Lighting Review* (Feb., 1944, p. 5). The needle area can be readily dealt with by means of direct light from fluorescent lamps mounted about 8 feet above the floor. In the mill described 25 ft.c. was thus furnished.

There remains, however, a second important area that needs light, the "overhead stop motion." Here the fine threads pass over on their way to the needles below. In the event of threads breaking the defect must be at once recognised, and the threads rejoined and replaced on the porcelain bobbins which hold them at the correct tension. It is important, therefore, that the operator should be able to see at a glance what is happening in this region.

In order to ensure quick vision the practice of placing upturned reflectors on the tops of alternate rows of "down" lights has been adopted. This furnishes 15 ft.c. of diffused lighting over the "stop motion" area.

There is, however, yet another question—the provision of a suitable background, against which threads can be easily seen. The irregular ceiling construction was not good in this respect, and it was judged necessary to provide an artificial background. The three chief colours used in this mill were khaki, air force blue, and white. It was found that an orange coloured background with a reflection factor of about 50 per cent. enabled all three to be seen well. A board of this colour, about 3 ft. square, has been attached to the ceiling immediately above each "stop motion." Operators state that the seeing conditions have been much improved and there has been a considerable saving in time on these operations.

I.E.S. Lighting Reconstruction Pamphlets

No. 1. Principles of Good Lighting.

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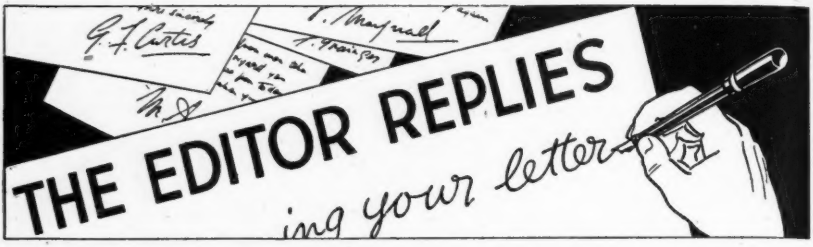

In the last issue of *Light and Lighting* (July, 1944, p. 112) I recalled the suggestion—made very early in the history of the I.E.S.—that the brightness of the sky should be adopted as an approximate limit for the brightness of sources coming within the direct range of vision. It has been objected that **all absolute limits to glare are wrong,** that effects of glare are essentially due to excessive contrast, and that even the brightness of the sky would be glaring if encountered in very weakly lighted surroundings.

This, of course, is quite true. Experience has shown that traffic signs having a brightness of the same order as that of the sky (2-3 candles per sq. in.) are unduly bright in streets furnished only with wartime lighting. I have recently met another instructive illustration of this. At some of the **Tube entrances** the concession has been made of cutting an aperture of several square feet in the protecting brickwork and introducing a shutter which is closed at night but left open by day. **The admission of daylight** is of great assistance to those entering and descending the stairway, as it does much to eliminate the otherwise paralysing contrast between the subdued artificial lighting inside and the bright sunlight out of doors. To people ascending the stairs, however, this exposure of several square feet of sky in the direct range of view is definitely glaring—in fact the drawback to them largely cancels the benefit to those coming down the stairs. An inclined shutter, allowing daylight to strike upwards but **cutting off the direct view of the sky** from ascending people, who would nevertheless benefit by the indirect lighting, would be a much better arrangement.

The use of the sky-brightness as a limit is naturally only expedient at the range of illuminations for which it is intended, i.e., those normally adopted for interior lighting. Even so, like all recommendations, it should not be followed too slavishly.

The adoption of stereoscopic views to illustrate the advantages of **"three dimensional painting,"** mentioned by Dr. Nelson in the article recently abstracted in *Light and Lighting* (July, 1944, p. 106), is a natural device when one considers that the main object of painting surroundings and parts of machines in light colours is to cause them to stand out, and to substitute a sense of perspective for the impression of flatness which surroundings in monochrome are apt to create. As Dr. Nelson points out, however, the device has to be applied with judgment. If *all* surroundings are light there may be insufficient contrast; or there may be reversed contrast, i.e., a background much brighter than the material viewed, which may be a handicap to clear vision.

There is also danger of monotony. The mere painting of objects in light grey may give rise to a rather dismal monochrome effect. I have seen factories in which the skilful use of **complementary colours** (e.g., lemon, yellow,

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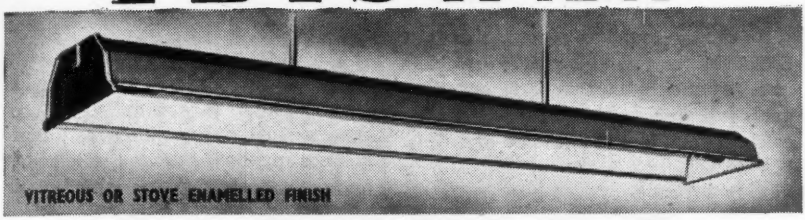

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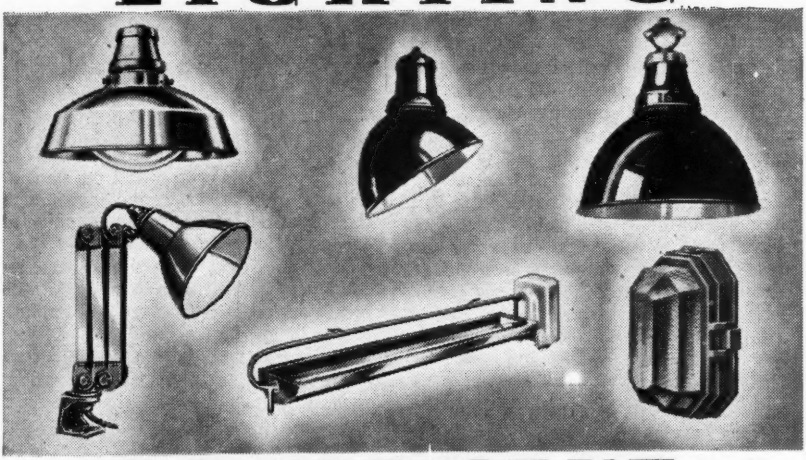

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or cream, for the walls and ceiling, and blue, in various tints, for the rafters and machines) gave rise to pleasing effects.

I recently found, however, that Mr. E. W. Murray, who has had considerable experience in this direction, does not entirely favour restricting the colours to a few complementary tints. His view is that the adoption of a **variety of colours** for objects, diverse but not too violent in tone, is preferable in two ways. In the first place it enables a supervisor or anyone entering a room to pick out objects more quickly; secondly, it has a valuable psychological effect on workers in recalling conditions in nature (e.g., in the garden) and dismissing from their minds the idea that they are in drab surroundings fitted to the "daily grind." Incidentally, the free use of colour has the advantage that good reflecting tints may predominate and yet we may preserve the requisite contrast, **i.e., contrast in colour,** which makes outlines distinct, even when the order of brightness is about the same.

My remarks in regard to the use of capitals have led to other comments on **literary style**—in which illuminating engineers, like other technicians, are apt to be deficient. I suppose the weakness most commonly pilloried is **the split infinitive**. "To entirely forget," "to readily acquiesce," "to tactfully decline" (instead of to forget entirely, to acquiesce readily, and to decline tactfully) are all wrong, though quite commonly used. Nevertheless, there *are* occasions when one's meaning is most clearly expressed by a split infinitive, in which case its use may be condoned even by the purist.

Tautology, unnecessary repetition of the same word, is also to be avoided; yet I hold that here, too, one should be bold and repeat a word twice, or even thrice, if this is expedient for clarity, a practice which legal draughtsmen delight to adopt.

The **termination of sentences with a preposition** is rarely excusable, and the effect almost invariably ugly. "An expedient he was quick to avail himself of," "a method enabling efficiency to be taken care of," "that is something I never thought of"—all wrong and ugly. The fault is an insidious one, however. There is the classic case of a schoolmaster who terminated his lesson with the remark, "So remember, boys, a preposition is *not* the thing to finish a sentence with."

Other mispractices to which technicians are prone, and which too quickly becomes current usage, involve the creation of **compound nouns** and the **conversion of nouns into verbs** or adjectives, or vice versa. "Lamp efficiency," "Fittings design," "Illumination practice," even "Illumination values" I dislike—in fact all such portmanteau words (in itself a lapse but a convenient one!). As regards the second fault, "to wire" is now so usual as to be ineradicable, but there is still time, perhaps, to relinquish "to lamp," "to photometer," and similar abrupt conversion of nouns into verbs.

ERRATUM

Our attention has been drawn to a little slip in the recent note entitled "Fluorescent Lighting to Facilitate Production" (June, 1944, p. 95)—the use of the name "Osira" to describe the tubular fluorescent lamps used. These lamps should have been described as "Osram," not "Osira," which is applied to discharge lamps of the ordinary variety.

Psychophysics and Photography

In what follows we give an abstract of a paper read by E. R. Davies to the Royal Photographic Society on May 30th, 1944, based on the work by Dr. L. Jones of Kodak Research Laboratories, Rochester, U.S.A.

Hitherto the field of psychophysics has been mainly developed by psychologists. It is concerned with the relationship between physical phenomena and their psychical interpretation.

The first important work in this field was done by Gustav Fechner, who in 1860 published "Elements of Psychophysics." E. H. Weber had previously carried out many experiments to determine the relationship between a stimulus and its resulting sensation, and he formulated what is known as Weber's law, which states that $\triangle R/R = \text{constant}$ where $\triangle R$ is the change in a stimulus R which produces a just noticeable change in the sensation S. Subsequently, Fechner deduced from the results of Weber the relationship known as the Weber-Fechner law, $S = k \log R$, where k is a constant. Fechner also laid down the foundations of the three methods of experimental technique which are used in every psychophysical investigation, though sometimes with modifications. These are:

(1) The method of just noticeable differences.
(2) The method of average errors.
(3) The method of right and wrong errors.

The third method has since been elaborated by Urban and is now in general use in the form of the Psychometric function. The observer is presented with a standard stimulus and with a variable stimulus differing from the standard by a known amount, upon which he is asked whether the variable stimulus produces a sensation which is greater or less than that produced by the standard. A large number of observations are made, and the percentage of right and wrong answers is plotted for each value of the variable stimulus.

An example of a psychophysical concept is the luminosity function, which has been wrongly defined both as the spectral sensitivity curve of the human eye, as if it were a function merely of the visual mechanism, and also as the luminous efficiency of radiant energy, inferring that it is only dependent on physical quantities. The function is now identified both with radiant energy and with sensation. The contrast sensitivity function, showing the sensitivity of the visual mechanism to brightness difference, is another psychophysical relationship, and is of great importance in photography.

The definition of the word "quality" as applied to a photograph has long presented many difficulties. "Quality" is dependent on two factors, the accuracy with which the brightness level and brightness differences in the original are reproduced in the illuminated positive, and also certain characteristics of the observer's visual sensory and perceptual mechanism. Dr. Jones determined by direct measurement the relationships between the light pattern existing in the original and in the illuminated positive, and then made a statistical determination of photographic quality in terms of the measured physical characteristics from the direct judgment of a large number of observers. A positive which reproduces perfectly the original object is not, in general, a good reproduction of the subjective impression of the original, chiefly because of the vastly different field environment of the original and the reproduction.

The physical characteristics of a photographic reproduction are determined both by the nature of the negative and positive materials, and by the exposure and treatment used. The knowledge of which print of a similar series is the best can be gathered only by inspection. Dr. Jones per-

formed a number of experiments in which he varied the negative exposure of a series of photographs, made the best possible print from each negative, and plotted frequency distribution curves showing the negative exposure for the the quality levels of "just acceptable" and "excellent," as appraised by a large number of observers. In order to establish a relation between the print quality of the quality of that print, Dr. Jones shuffled the prints and asked his observers to arrange them in order of increasing quality. Representing the number of times a print appeared in each position multiplied by the index number of that position as a measure of the quality of that print, Dr. Jones was able to produce a curve relating print quality with negative exposure. This type of curve indicated the order of quality only, and did not measure the quality interval.

From the results of these experiments Dr. Jones expressed the speed of a photographic negative as something which should be evaluated in terms of the minimum exposure which will yield a negative from which an excellent print can be made. Taking the curve of density against log exposure for a negative material, the position on the curve of points giving "just acceptable" and "excellent" prints can be marked as a result of psychophysical measurement, thus giving the minimum exposure for an excellent print, and from this information Dr. Jones has been able to fix a purely sensitometric criterion for the judgment of quality which agrees very well with the psychophysical data.

As a second part of Dr. Jones's investigations, a large number of negatives were made of a wide variety of exterior scenes, and the best possible print made from each. From the characteristics of these prints, an attempt was made to define the useful part of the characteristic of the positive printing paper, and as a result of the analysis of the best prints a relation was found between the density scale of a negative and the useful exposure scale of the positive material which produces the best possible print. The best criterion of correct printing exposure appears to be, from Dr. Jones's work, the minimum negative density, and not the average or maximum density.

In conclusion, Dr. Jones's work emphasised that it is hopeless to attempt to obtain adequate solutions to the problems of quality from pure application of objective tone reproduction theory, and the psychical response which governs the judgment of print quality involves, besides perception, possibly more complicated modes of mental functioning.

In the discussion which followed, Mr. Guild pointed out the importance of the new method of approach which Dr. Jones had used. He had doubts about the correctness of the way in which Dr. Jones interpreted "excellence of print," and felt that the method in which several prints were seen in juxtaposition was not a good one for judging excellence. Regarding the possibility of establishing a "quality" scale, Mr. Guild thought that this would be difficult, and that "better" or "worse" were the only criteria necessary. The object of the experiments had been to correlate "quality" with sensitometric parameters in such a way that excellent reproduction could be achieved by following a simple procedure worked out from data given regarding the physical characteristics of the materials.

Points arising in the subsequent discussion tended to show that some members had uncertainties about the validity of Dr. Jones's methods, whilst others were disturbed by the use of the word "psychophysics." The validity of any scale of "quality" was questioned.

Answering further questions, Mr. Davies said that Dr. Jones's measurements were relative to the particular materials he was using. Mr. Chilton emphasised that many of his conclusions would have to be altered if materials with different characteristics were employed, and pointed out that printing papers largely predetermined the results, as there was so little freedom of choice.